

PROGRESS REPORT
SPEED REDUCER 80:1 RATIO
ORDER XG-866
FOR GN-58 GENERATOR WITH UGP-12 ENGINE

CONFIDENTIAL

JACOBSEN MANUFACTURING COMPANY
RACINE, WISCONSIN
APRIL 27, 1954

Speed Reducer for GN-58 Hand Cranked Generator.

The purpose of this contract was to develop a speed reducer which would be integral with the UGP-12 two-cycle gasoline engine. The speed reducer was to be as light and compact as possible and facilitate rapid installation on the GN-58 generator to provide relief from hand cranking when operated for prolonged periods of time.

Having precluded that a compound planetary type gear system would give the required speed reduction with a minimum of parts, a small hand rotated unit was constructed from available components. Gear compliment and ratios were as indicated on sketch number one. Operation of the unit was promising and all indications were that it would provide the desired reduction.

In the interests of uniformity and simplicity, it was decided that the UGP-12 generator case be used for a housing. Investigation of this possibility revealed that it was practicable. A generator housing was reworked to accommodate the gearing. The completed assembly corresponded closely to that shown on sketch number one, which shows relative positions of gears and driving spider. In this instance there were but two sets of planetary gears; all gearing was 20 pitch, 14-1/2° Pressure Angle. Plain bearings were used thru-out.

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Initial tests indicated proper speed reduction, however, noise level was high and considerable frictional drag placed an objectionable load on the engine.

It was at first concluded that frictional drag was being caused by unequal tooth pressures between the second stage planetary gears. The planetary spider was reworked to accommodate three sets of planetary gears. At this point it was found that it was difficult to properly mesh or time the gear train and that an assembly and maintenance problem was inherent. A trial run exhibited little improvement in frictional load reduction.

The next step was to equip the planetary gears and the output internal gear with anti-friction bearings. This was accomplished by reworking parts already in use. The assembly was again tested and results were gratifying. The load placed on the engine had been reduced considerably and excepting for the relatively high gear noise it appeared that progress had been made.

The next problem was to construct a suitable mounting for assembly to the GN-58 generator. The first design, sketch number two, had the UGP-12 engine with speed reducer mounted below the GN-58. Suspension was from the hand crank sockets. A sprocket and chain drive coupled the two units together. The arrangement provided a compact installation, but placed a rather heavy load on the GN-58 bearings. In addition, assembly of the driving unit to the GN-58 was rather difficult and in all probabilities required the help of two persons.

Even though it was concluded that the foregoing method of suspension was unsatisfactory, it was decided to run a full load test. It was disappointing to find that the UGP-12 was unable to drive the GN-58 at the rated speed, thus, indicating abnormal gear con-

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ditions.

A review of gear calculations was made wherein it was discovered that 20° pressure angle teeth should have been used in lieu of 14-1/2° P.A. A new set of 20° P.A. tooth gears were made, the unit was again tested and this time the engine pulled a full load without difficulty and with power to spare, but gear noise was still excessive.

A set of formica planetary gears were made and tested under full load, but after less than an hour of operation the teeth of the planetary gears had become completely sheared off.

In the meantime a clutch had been added, sketch number one, to relieve the tremendous load placed on the engine during the starting operation. The clutch performed very well and permitted easier engine starting and allowed gradual engagement of the gear train.

At this point, three formica planetary gears were tried with inherent timing difficulty in hope that the additional gear would reduce tooth load. It was soon learned that little benefit was derived from the additional gear.

The planetary system was abandoned. A new layout, sketch number four, was made using conventional 20 pitch 20° pressure angle spur tooth gears having a three stage reduction. While new gears and the housing were being made, it was decided to change the method of mounting the engine to the GN-58 generator. The new mounting corresponds to sketch number five, engine not shown. The chain drive as used previously was again employed.

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The new method of mounting the engine is extremely simple and facilitates assembly by one person, and, at the same time permits the use of the tree holder which was included for your approval and comments. In addition, the new method of mounting permits operation of the GN-58, when engine or hand driven, either in place on the tri-pod or on the ground, either engine driven or hand cranked while in place on the tree holder.

Tests with the new gear train indicated extreme torsional load on the driving shafts which fit in place of the hand cranks. After a small number of engine starts, these shafts would become twisted, and in several instances they were twisted off completely.

The clutch used in the previous planetary gear drive aided in starting and removed the tremendous load during that operation, but was of no benefit in the event of erratic engine operation. A load of the same amplitude being present, only in reverse.

It was conceded that the load inherent while starting was of little consequence because of the gradual speed up taking place as the starter cord was being pulled.

The chain drive was reworked to include a simple ratchet type over-running clutch which performed as expected for its inability to withstand the extremely heavy load.

A torsion spring was incorporated with the expectancy that it would absorb sufficient shock load, but this too proved unsatisfactory under certain conditions of engine mal-function.

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At this stage it appeared that all efforts had been in vain, but there still remained the possibility of using a belt drive. A new drive coupling was fabricated using "V" pulleys and belt. The first sample had an over-center lever operated clutch which first tests indicated would not be required.

The over-center clutch was removed and replaced with a spring loaded idler pulley which kept the belt under proper drive tension, yet permitted the belt to slip under abnormal engine loading or mal-function.

This unit was placed on test and permitted to run for 24 hours with a constant full load across the output of the GN-58 generator. The unit was next taken apart and examined for wear. Not showing signs of abnormal wear, the unit was placed under a more severe test.

A small electric speed reducer was equipped with four rotating radial fingers which were arranged so as to actuate the UGP-12 carburetor throttle 22 times per minute. Engine speed at full load was 4800 revolutions per minute, and was air vane governor controlled; provisions having been included in UGP-12 design to incorporate the air vane if required. Full load was placed on the GN-58 generator. The rotating radial fingers were set to close the throttle which permitted the engine to slow down to approximately 300 revolutions per minute and suddenly allow the throttle to snap to full throttle position. This test submitted all components to the extreme loads present and simulated conditions of engine malfunction.

This test was conducted for a total time of 29.6 hours during which time the engine

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had been cycled 39,072 times from closed to full throttle.

Examination after this test revealed no abnormal conditions of wear, strain or looseness in either the engine proper or the speed reducer.

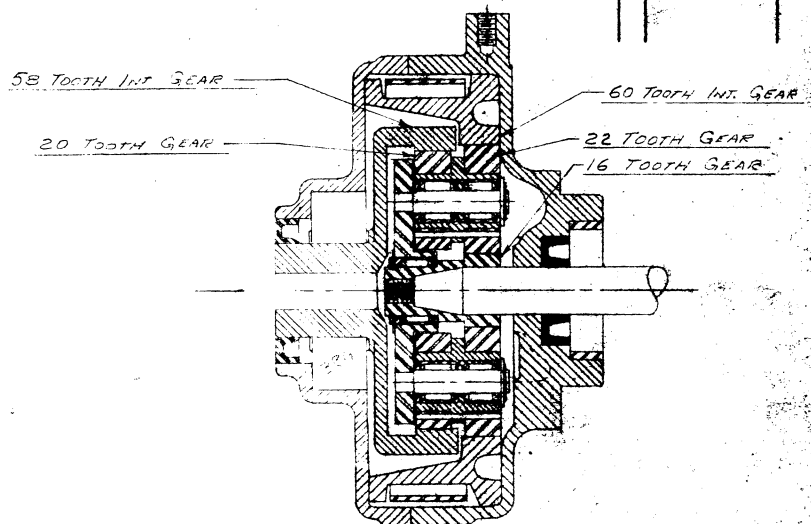
Having concluded that the belt drive was entirely practicable, and that the speed reducer fulfilled requirements of performance, and that the engine was capable of supplying the necessary driving power the unit was delivered to the contracting agency for observation.

It should be understood that the sample unit submitted does not constitute a finished product, but instead is a model which is hand built, and for the most part without the aid of drawings. There are numerous minor mechanical modifications that should be made to improve over-all mechanical stability, however, it was more expeditious to obtain agency reaction before attempting any further work on either the speed reducer or detail drawings.

The unit was shipped before photographs had been taken, hence, a photo does not accompany this report.

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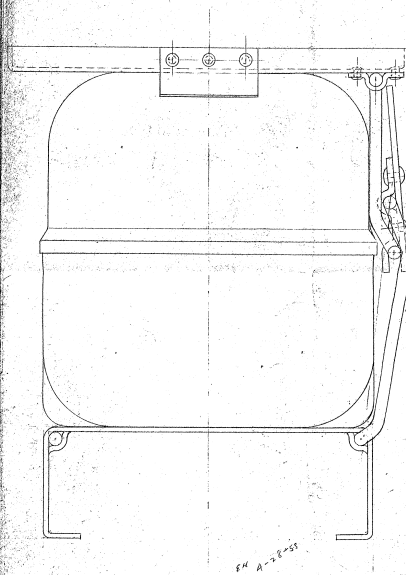
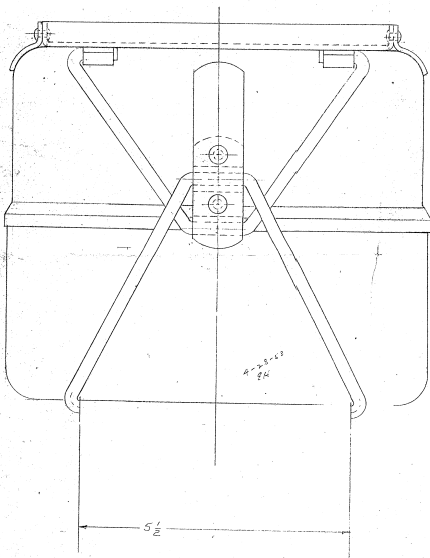


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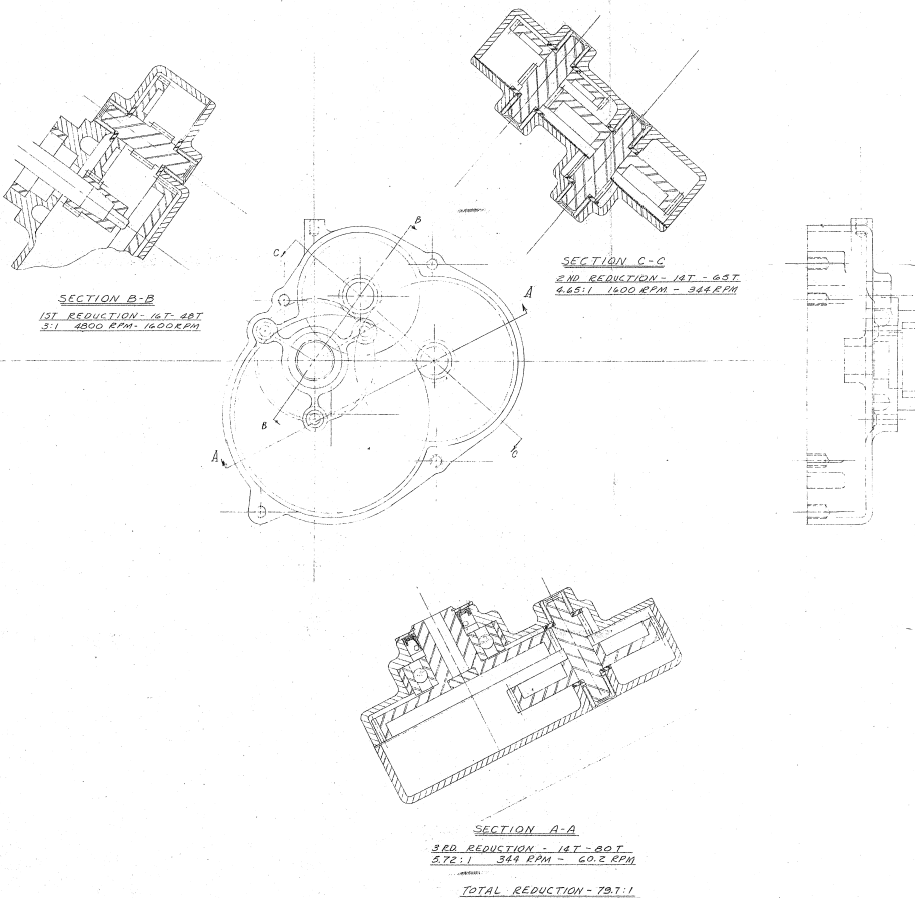
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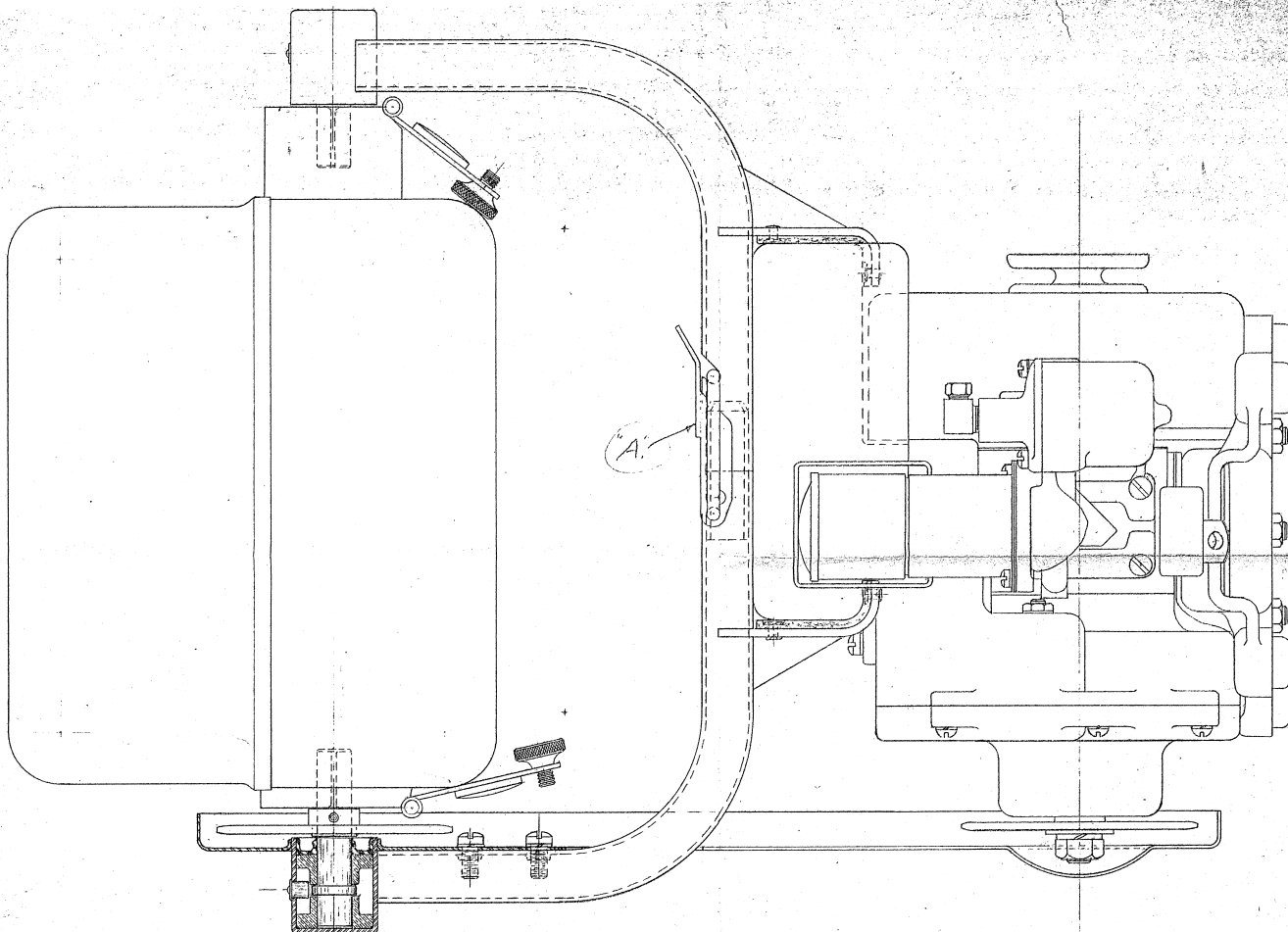
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NOTE
THIS MODEL WAS MADE, WITH
EXCEPTION OF CLAMP "A" AND CHAIN GUARD
MOUNTING SEEMED SATISFACTORY EXCEPT
DIFFICULT TO ATTACH.
GEAR REDUCER UNABLE TO DRIVE AT
PROPER SPEED - DUE TO INTERNAL FRICTION

ALLOWABLE VARIATIONS ON FRACTIONAL
DIMENSIONS LOCATIONS FINISHED SURFACE
IS TO OR - .010 ON DECIMAL DIMENSIONS
AND .005 ON FRACTIONAL DIMENSIONS
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BY 7/15/57 DATE 7/15/57 SUBJECT GEAR TRAIN SHEET NO. 1 OF 1
 CHKD. BY DATE JOB NO. 23-4488

20 PITCH 20° P. ANGLE

DRIVING GEARS

60 TEETH
 P.D. 3" — R.P.M.
 I.D. 2.885

22 TEETH
 P.D. 1.100 * — R.P.M.

16 TEETH
 P.D. .800 4800 R.P.M.

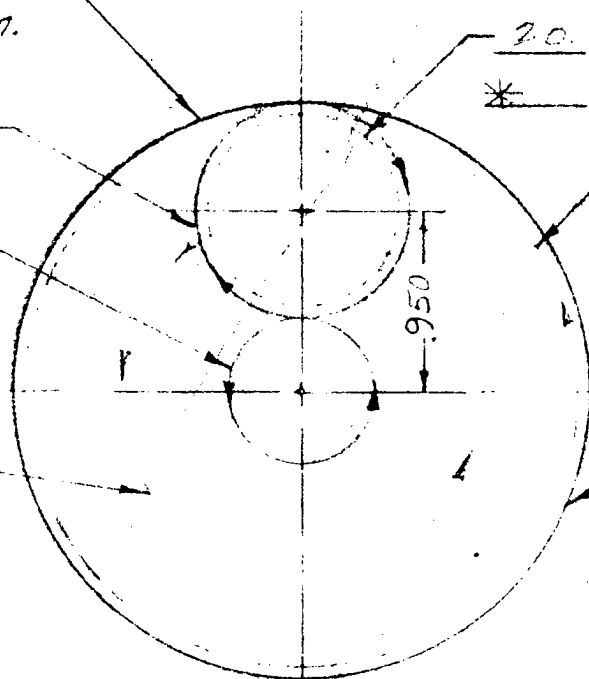
DRIVEN GEARS

20 TEETH
 * — R.P.M. P.D. 1"

58 TEETH
60.72 R.P.M. P.D. $2\frac{7}{8}$
 I.D. 2.76

1010.5 R.P.M. OF SPIDER

FIXED



75-1 RATIO DRIVING GEARS

0.576-1 RATIO DRIVEN GEARS

80-1 RATIO — TOTAL REDUCTION

* THE 20 TEETH & 22 TEETH P.W.D. GEAR, WHICH ARE HELD TOGETHER, REVOLVE AROUND THEIR OWN AXIS 2.72 RPM PLUS 1 RPM OF THE SPIDER AROUND THE SUN GEAR

SKETCH #3

JACOBSEN MFG. CO.